

*Thirty-seventh Annual Report of the Savilian
Professor of Astronomy to the Visitors of
the University Observatory for 1911-12.*

BOARD OF VISITORS, 1912.

THE VICE-CHANCELLOR (Charles Buller Heberden, M.A., Hon. D.C.L.,
Principal of Brasenose).

THE SENIOR PROCTOR (William H. V. Reade, M.A., Tutor and Dean of
Keble).

THE JUNIOR PROCTOR (Richard Winn Livingstone, M.A., Fellow and
Assistant Tutor of Corpus Christi).

THE ASTRONOMER ROYAL (Frank Watson Dyson, LL.D., F.R.S.).

THE DIRECTOR OF THE CAMBRIDGE OBSERVATORY (Sir R. S. Ball,
M.A., LL.D., F.R.S.).

THE RADCLIFFE OBSERVER (A. A. Rambaut, M.A., D.Sc., F.R.S.).

EDWIN B. ELLIOTT, M.A., F.R.S., Fellow of Magdalen. } For ten years until
CHARLES LEUDESDOFF, M.A., Fellow of Pembroke. } Nov. 10, 1915.

WILLIAM ESSON, M.A., F.R.S., Fellow of New College. } For ten years until
SIR W. H. M. CHRISTIE, K.C.B., Hon. D.Sc., F.R.S. } Nov. 10, 1920.

THE Report here presented refers to the period from May 1, 1911 to April 30, 1912, and exhibits the state of the Observatory on the last-named day.

As a brief summary it may be stated that the comparison of repeated plates has been completed: that good progress has been made with the experiment on obtaining differential places of reference stars by photography, with very promising results: that the work of preparing Vol. VIII (the Discussion Volume) of the Astrographic Catalogue is proceeding steadily: and that several theoretical investigations of importance have been published.

I. Buildings and Grounds.

There is little to report this year, beyond the fact that it is impossible to keep the large dome water-tight. The leakage through it in wet weather is gradually getting worse in spite

of all attempts to prevent it. The very dry hot summer of last year was of course a severe trial ; but there was leakage before that. Perhaps careful painting in the forthcoming summer may improve matters. The corridor between the domes is also gradually getting worse in respect of leakage ; and it may be that some effective repairs will be necessary within a few years.

Mr. Mullis has made it possible to throw out (or in) all the electric lights in the building from the front door. On leaving the premises at night, therefore, it is easy to cut off all the current—a sensible diminution in the risk of fire.

II. Library and Movable Property.

During the year 257 sheets of the Astrographic Chart have been received, of which 205 are of regions South of the Equator, hitherto not well represented. The total number received is 2,899, of which 677 are South of the Equator. The transference of the sheets to the new case has not yet been undertaken.

The binding of Observatory publications is up to date.

The card catalogue of the bound pamphlets has been made for 50 of the 170 volumes.

III. Instruments.

The chief instruments are in good order. A kind benefaction (£50) by Mr. J. E. Pearson was devoted to the purchase of a glass cube made by Professor G. W. Ritchey, of Pasadena, 4 faces of which are silvered. This will be used for the work on obtaining fundamental star-places by photography, when the time arrives for this investigation. At present our attention is claimed by the differential method.

IV. Observations and Reductions.

In the last report a method of obtaining differential places of the reference stars by photography (using the Astrographic Equatorial simply as it stands to obtain a number of regions on the same plate, all exposed at precisely the same hour-

angle, and zenith distance) was described. This method is being given a thorough trial. The first experiments were so promising that it was determined to apply the method to the whole of the reference stars for one complete zone ($+29^{\circ}$). At present nine plates have been secured in this zone, and most of them measured. The following particulars may be given:—

Date.	Limits R. A. of Centre.	No. of Centres.	No. of Exp.	No of images measured.	No. of C. stars concerned.
1911 Dec. 20	0.58—2.1	8	22	2065	557
1911 Apr. 3	8.46—10.7	10	28	1595	248
1912 Apr. 3	9.49—11.1	9	24	760	226
1912 Apr. 6	10.7—11.46	12	33	(not yet)	271
1912 Apr. 19	12.22—16.7	25	73	(not yet)	617
1911 May 24	15.40—16.43	8	23	1100	215
1911 July 21	18.31—20.28	14	38	6980	1174
1911 Nov. 16	20.28—21.4	5	18	1880	426
1911 Nov. 29	21.14—22.25	9	26	2100	524
Totals to date	Two-thirds of zone	100	285	16450	4258

It will be seen that a good overlap has been secured in several places, which will allow of the results from different nights being compared. Several plates are practically fully reduced, and one has been carefully discussed for systematic errors (*Mon. Not., R.A.S., LXXII, p. 91*). It is hoped that the next Report may include an account of the successful completion of this new departure in differential observing. It should however be remarked that though the procedure is essentially labour-saving, there is still a good deal of work involved in observing a zone on the scale undertaken. The number of star places to be observed may fairly be compared with the number which not very long ago occupied a large observatory like Greenwich some ten years or more (though modern expansion has rendered this comparison less appropriate). It will probably not be necessary, or even advisable, to extend the work on this scale to the whole sky; but in the first trial of a new method it seems desirable to aim at comprehensiveness. The Government Grant Committee of

the Royal Society have made a second grant of £100 in view of the amount of labour involved.

The work of comparing duplicated plates, when the repetition followed the original after at least 10 years, has now been completed by Mr. Bellamy: the final stage occupying him almost continuously for four months. In all, 175 pairs of plates, containing 30,000 star images, have been compared, and 750 stars have shown sensible displacement, which gives an average of about 4 stars per plate. These stars are our nearest neighbours, and are scattered indifferently round our sun. Taking the average interval between plates as 13 years, then when this interval is doubled (which will become possible for some plates in half a dozen years from now) we ought to get similar results for stars at twice the distance from us, which would be approximately 8 times as many. Before very long therefore the work of repeating plates may be undertaken with the confident hope of finding a fair number of proper motions. Meanwhile it seems probable that a certain amount of volunteer help will be available for measures on plates which may be repeated for one reason or another. Mr. J. F. McNeile, of Wellington College, and Mr. W. E. Curtis, of the Royal College of Science, have already made valuable contributions of this kind.

Unfortunately, only two portions of the Astrographic Catalogue (Greenwich and Oxford) are yet completed, and very few are well advanced. Practically no results for the Southern Hemisphere have yet been published. It becomes clear that unless a helping hand is extended to the weaker observatories, this great work will drag on indefinitely. A commencement was made in this direction at this observatory a few years ago by the measurement of some of the plates taken at Perth (W. Australia) with the aid of a small grant from the Government Grant Fund: but it was not found possible to proceed far, and this auxiliary work was ultimately taken over by Professor Dyson while Astronomer Royal for Scotland, and is being continued by his successor, Professor Sampson. Recently it came to my knowledge that similar

help would be appreciated on the part of the Vatican Observatory, and Mr. A. F. Lindemann generously offered a benefaction to start the work. In consequence the reductions for the Vatican zone $+64^\circ$ have been carried out by a non-resident computer under the general supervision of this observatory. The measures are made in Rome (by the ladies of a religious Order) under the supervision of the Director of the Vatican Observatory. They are then sent here to be transmitted (with instructions) to the computer, who returns his computations here for inspection. There is thus no call on the funds of the observatory for the main expense, and only a very slight call on its time: but the experience gained in the work on our own zone is made available for helping another observatory, and very kindly appreciation of the help has been expressed. The work quickly bore fruit in suggesting certain modifications in the method of measurement which were adopted with very little waste; though had the reductions not been started, there might have been considerable loss of labour and time. This work was undertaken without prejudice, as an experiment to be justified or abandoned; but I have an earnest request from the Director of the Vatican Observatory to carry it through, and I understand that funds will be forthcoming for the computations. It is therefore only necessary for the Visitors to signify their general approval of the extension of a helping hand, so far as it involves the spending of an occasional hour or two in inspection of the work done.

During the year yet another New Star appeared in Gemini, very near the one discovered here by photography in 1903. As has become almost habitual, Mr. Bellamy took a photograph of the region, and measured 100 faint stars surrounding the Nova.

V. Printing and Publication of Results.

The last volume of measures (zone $+25^\circ$), being Volume VII of the Oxford Astrogaphic Catalogue, was distributed, in accordance with established practice, to observatories and institutions from most of which we receive corresponding

publications: but a few copies of our Catalogue have also been purchased in the open market, which is agreeable testimony to their usefulness.

It may interest the Board to learn that the 4,375 volumes which have been delivered at this Observatory since 1907 weighed in all some $5\frac{3}{4}$ tons. Of these some 3 tons (2,340 volumes) have been packed, addressed, and distributed; a considerable piece of labour of a kind that is sometimes forgotten in estimating the work of an astronomical observatory. By kind permission of Bodley's Librarian, 100 copies of each of the seven volumes are temporarily stored in the Savilian Library, and the remainders are in the Observatory. But it is urgently necessary to find some more suitable arrangement for this duplicate storage. Leave has only been given by Bodley's Librarian for a limited time.

We are now at work on Volume VIII, which is to contain general discussions of the results: and firstly on the "Ledgers" which have been kept of the reference stars. When the residual errors for the same star found from different plates are placed side by side, a number of cases of discrepancy present themselves for examination. Some of them denote actual movement in the star between one date and another: others denote mistakes which have occurred outside the printed volumes: a residue (happily a very small residue) are found to be mistakes requiring "errata" in the printed volumes. This examination is now carried out over about half the work.

The following papers have been published by members of the staff during the year:—

"Johann Gottfried Galle, 1812-1910." By F. A. Bellamy, *Knowledge*, Aug. and Sept. 1910.

"Fourth Note on the Number of Faint Stars with Large Proper Motions in the Oxford Zones + 29°." By F. A. Bellamy, *Mon. Not.*, LXXI, p. 582 (May, 1911).

"Observations of *α Orionis* by the late Joseph Baxendell, F.R.S., together with the Magnitudes deduced from the

Observations of Sir J. Herschel and of Argelander." Edited by H. C. Plummer, *Mon. Not.*, LXXI, p. 701 (June, 1911).

"What can we learn from Rainfall Records?" By H. H. Turner, *Quart. Jour. Royal Meteorological Society*, XXXVII, p. 209 (July, 1911).

Address to the Mathematical and Physical Section of the British Association. By H. H. Turner (Sept. 1911).

"Fifth Note on the Number of Faint Stars with Large Proper Motions." Zone + 25°. By F. A. Bellamy, *Mon. Not.*, LXXII, p. 65 (Nov. 1911).

"The Determination of Differential Star Places by Photographic Methods." First Paper. By H. H. Turner, *Mon. Not.*, LXXII, p. 91 (Dec. 1911).

"Hypothetical Parallaxes of the Brighter Stars of Type A." By H. C. Plummer, *Mon. Not.*, LXXII, p. 170 (Jan. 1912).

"An Example of the use of Spherical Harmonic Analysis." By H. H. Turner and F. G. Brown, *Mon. Not.*, LXXII, p. 203 (Jan. 1912).

"A tentative explanation of the 'Two Star Streams' in Terms of Gravitation." By H. H. Turner, *Mon. Not.*, LXXII, p. 387 (Mar. 1912).

"A Proposal for the Comparison of the Stellar Magnitude Scales of the different Observatories taking part in the Astrographic Catalogue." Second Note. "The Bordeaux Magnitudes." By H. H. Turner. (*Mon. Not.*, April, 1912. In the press.)

"A tentative explanation of the 'Two Star Streams' in Terms of Gravitation." Second Note. "The Position of the Centre of our System." By H. H. Turner. (*Mon. Not.*, April, 1912. In the press.)

"Positions and Magnitudes of Nova Geminorum II (Enebo) and 102 Stars in the near Neighbourhood." By F. A. Bellamy. (*Mon. Not.*, April, 1912. In the press.)

A word or two may be added on a few of these papers. A short time ago the Board kindly authorized special arrangements, which enabled Mr. H. C. Plummer to spend a year at

the Lick Observatory (California), where he became familiar with modern apparatus for spectroscopic work, and where his own mathematical skill was much appreciated. As a sequel, Professor W. W. Campbell, the Director of the Lick Observatory, recently communicated to him in MS. a digest of his store of observations on certain classes of stars, in the hope that his proved capacity for elucidating the main features of the results might again find opportunities. This fortunately proved to be the case. Adopting a simple hypothesis suggested by the observations themselves, Mr. Plummer has been able to deduce the probable distances and actual velocities of the stars; and the probability of his results is enhanced by the fact that they gather the stars into separate groups, in a manner already foreshadowed by quite independent work. This work has, moreover, proved of vital importance in developing the hypothesis of the constitution of our stellar system, represented by two of the papers by the Professor at the end of the list. In these papers it is suggested that our Sun and its attendant planets form a single unit in a system of stars, of dimensions vast compared with our solar system, but small compared with the distances separating it from similar neighbouring systems. Further, that the units similar to our sun are describing orbits (not of an open or circular character, but more closely resembling the oscillations of a pendulum bob), in response to the gravitation of the whole system, which has a "centre of gravity". The suggestion is so new that it is in need of much closer scrutiny before it can be either accepted or rejected definitely; but many independent facts are collated by it, among which may be specially mentioned that the velocities of one of the groups of stars detected by Mr. Plummer fall in with the idea of an acceleration directed towards the specified centre, which may be put provisionally at some 70 to 90 light-years away from us, in the direction R.A. $6^h 15^m$, Dec. $+12^\circ$. Without laying any stress on the provisional figures, but purely by way of illustration, it would seem on this hypothesis that our Sun describes its orbit in (say) 400 million years; and was near the centre less than a million years

ago—perhaps as lately as 300,000 years ago—and is now outward bound.

VI. Lectures and Visitors.

The course of Lectures by the Professor on the Astronomy required for the Mathematical Final Schools was delivered, as usual, in the Michaelmas and Hilary Terms, and Mr. Plummer has given practical instruction.

Six lectures were also given in Oxford for the University Extension Delegacy.

The second "Halley" Lecture was delivered by the Professor in the Schools on May 22 last, on "the Movements of the Stars".

On July 9, August 7, and August 10, parties of students connected with the Tutorial Classes movement visited the Observatory and were given brief explanations of its work: about 25 to 30 in each case.

Mr. J. H. Worthington, who has occasionally worked at the Observatory, took a private expedition to Vavau to observe the eclipse of 1911, April 28, and was favoured with fine weather when practically all the other parties were unfortunate. On his return he deposited his photographs at this Observatory and help was given him in preparing lantern slides from them and presenting the results to the Royal Astronomical Society.

Mr. R. S. Capon of St. John's rendered volunteer aid to Mr. Plummer in his calculations of the parallaxes and velocities of stars, above mentioned.

VII. Personal Establishment.

The continuous devotion of Mr. Bellamy who will soon complete 20 years' service, and of Mr. Plummer, who has already completed 10 years', are already manifest from what precedes. Mr. Plummer's memoir on the parallaxes is not yet fully published, as it was placed in the hands of Professor Campbell who supplied the material. But it forms in my opinion a contribution of sterling merit to a rapidly developing modern line of research. Work of this kind, by no means

the first from the same source, should surely meet with the recognition of a Research Fellowship in this University?*

Miss E. F. Bellamy, who originally came occasionally to assist her uncle in miscellaneous ways, has gradually become expert not only in computing, but in many phases of our work. She has carried out with success a considerable portion of the examination of discordances in the ledgers, work which requires familiarity with all the processes of measurement and reduction. And in matters requiring, perhaps, less knowledge but where care and accuracy are also valuable, such as the distribution of our volumes, and the cataloguing of pamphlets, her work has been of great use. Her small salary has hitherto been provided from various sources—from successive Government grants when she has done work definitely of the kind for which they were provided; and from our Observatory funds when she has (for instance) been distributing the volumes. I suggest that the time has come, after more than a dozen years during which her services have steadily grown in value, when she might receive a definite appointment.

Mr. S. C. Cook has measured the plates of superposed regions steadily through the year; and has been re-engaged for one year more: his salary being provided from the Government grant for this work.

The services of Mr. J. Mullis were deservedly recognized by the Board last year; and he has continued to justify the recognition.

H. H. TURNER.

UNIVERSITY OBSERVATORY,

May 1, 1912.

* Since these words were written, Mr. Plummer has been appointed Royal Astronomer for Ireland.